Examiners' Report
Lead Examiner Feedback

January 2022

Pearson BTEC Nationals
In Applied Science (31619H)
Unit 3: Science Investigation Skills

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Grade Boundaries

What is a grade boundary?

A grade boundary is where we set the level of achievement required to obtain a certain grade for the externally assessed unit. We set grade boundaries for each grade, at Distinction, Merit and Pass.

Setting grade boundaries

When we set grade boundaries, we look at the performance of every learner who took the external assessment. When we can see the full picture of performance, our experts are then able to decide where best to place the grade boundaries – this means that they decide what the lowest possible mark is for a particular grade.

When our experts set the grade boundaries, they make sure that learners receive grades which reflect their ability. Awarding grade boundaries is conducted to ensure learners achieve the grade they deserve to achieve, irrespective of variation in the external assessment.

Variations in external assessments

Each external assessment we set asks different questions and may assess different parts of the unit content outlined in the specification. It would be unfair to learners if we set the same grade boundaries for each assessment, because then it would not take accessibility into account.

Grade boundaries for this, and all other papers, are on the website via this link:
http://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

Awarding BTEC qualifications in 2022

Ofqual has set out their plans for awarding qualifications in 2022 and intend to return to a normal, pre-pandemic, approach to grading standards over by 2023. They have confirmed that 2022 will be a transition year, to reflect that we are in a pandemic recovery period and students' education has been disrupted.

Our guiding principle and approach to awarding BTEC qualification results in 2022 will be to ensure parity in relation to the approach being taken for GCSE and A level learners. BTEC courses have a different structure and design to academic qualifications - BTECs are modular qualifications (with assessments taking place throughout the course) compared to GCSEs and A levels which are linear (assessed and awarded at the same time at the end of the year), and therefore our approach needs to be different.

In 2022 we will return to the usual method of calculating BTEC qualification results, however adaptations including, U-TAGs and reduced internal assessment, are in place to provide a comprehensive package of support for students.

The basis of our awarding approach to BTECs this year is to ensure it is as fair as possible for all learners. We will use a range of evidence to set grade boundaries for the external units. Part of this evidence will be to closely monitor learner performance in all assessments that contribute to learners' final qualification grade, to ensure parity with A level and GCSEs.

Further information can be found on our website and via our Social Media channels.

Unit 3: Science Investigation Skills

Grade	Unclassified	Level 3			
		N	P	M	D
Boundary Mark	0	8	16	27	39

Introduction

Biology

This was the second time that the altered approach to Part A of the examination was provided. The Part A in the January 2022 series gave a method for an investigation about biological sampling, using a line transect around a tree to investigate the effect of directional aspect on the growth of *Pleurococcus.* Learners were given Part A to study and make notes for 45 minutes before starting Part B. Information about *Pleurococcus* and the method used, highlighting key variables, such as the height from the ground, were given, along with raw data for the learners to analyse throughout Part B, Section 1.

Introduction to the Overall Performance of the Unit

Learners seem to have adjusted well to the difference in format, but some learners still found it difficult to produce a properly organised table of results from which a bar chart graph could be draw. Some learners did not follow this instruction and instead gave a line graph- learners should ensure that they read the instructions carefully so that they produce the required graph. Learners usually showed working for calculations and were often able to successfully substitute and calculate the t-test value. Suggesting ways in which the investigation could be improved to give a more accurate value for percentage growth of *Pleurococcus* proved to be challenging, which a majority of learners suggesting changing a variable within the investigation rather than a valid improvement. Learners were generally able to suggest control variables and the relationships between the growth, directional aspect, and light intensity.

Introduction

Chemistry

Section 2 of this paper consists of two questions which are taken from a different scientific discipline to the questions in Section 1. Section 2 of this paper focused the learners on their understanding of the Chemistry part of the specification and concentrates, in question 4, on 'Planning a

scientific Investigation' and, in question 5, on 'Drawing conclusions and evaluating'

Introduction to the Overall Performance of the Unit

Learners that did well, approached their answers in a logical way, interacted with the stimulus in the question and gave their responses in a well-structured way, ensuring that they addressed everything asked of them in the question. They related their answers to the context set rather than generic answers.

Individual Questions

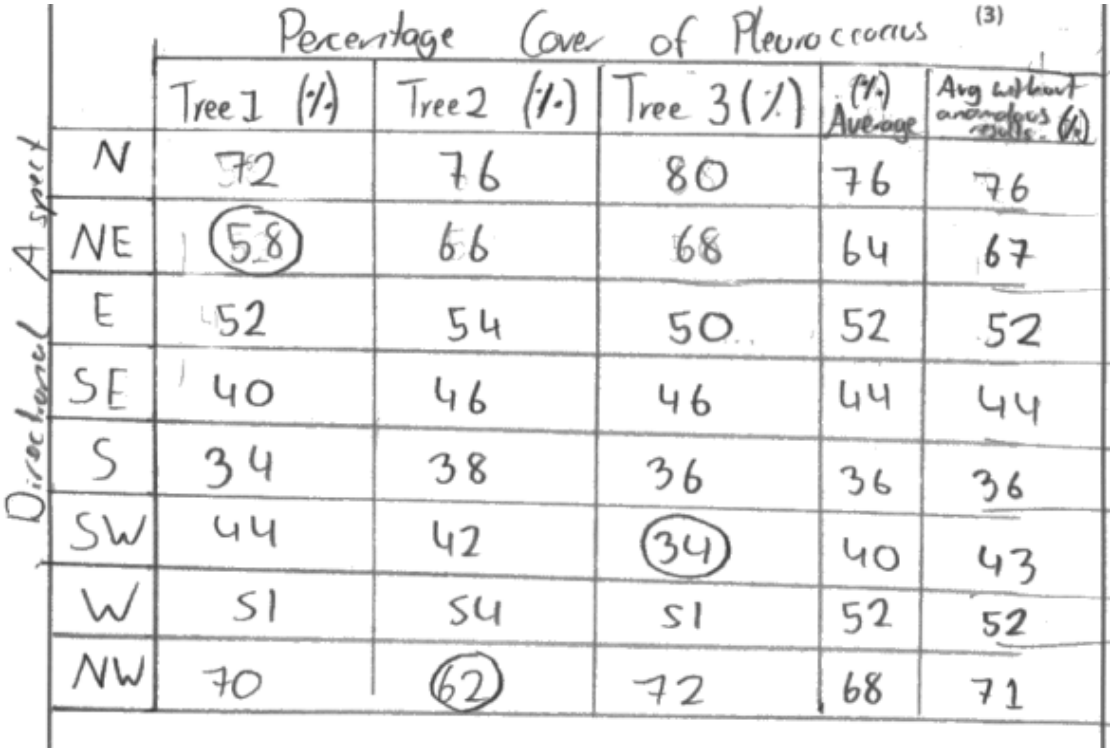
Biology

Q1(a)

The standard of learner-drawn tables was considerably higher than in previous years. Rows and columns were, in general, titled correctly and almost all users attempted to calculate means. Marks were most often lost for failing to label the Directional Aspect column or failing to mention that the percentages related to *Pleurococcus* cover. A number of students provided tables of light intensity data, which was not required, highlighting the importance of reading the question carefully.

This response was awarded 3 marks. The learner has given suitable headings with units- we do not expect a unit for (direction/ directional aspect) and % or percentage for cover of *Pleurococcus*. If the learner has indicated in the title that it is percentage cover, they do not need to have the symbol % in the column headings.
The measurements are consistent- we would expect this as the data was given but could be made inconsistent if the means are calculated with decimal places.

The 3 repeats and the means have been given- here the learner has given the average with all 3 data points included and has given the average without the anomalous results that they have highlighted. Either is acceptable.



Percentage Cover of Pleurocerus (3)

Direction from A spruce	Tree 1 (%)	Tree 2 (%)	Tree 3 (%)	(%) Average	Avg without anomalous results (%)
N	72	76	80	76	76
NE	(58)	66	68	64	67
E	52	54	50	52	52
SE	40	46	46	44	44
S	34	38	36	36	36
SW	44	42	(34)	40	43
W	51	54	51	52	52
NW	70	(62)	72	68	71

Lead Examiner comment: *This response was awarded 1 mark. Unfortunately, the learner has not given the repeats, although they have correctly calculated the means. The table does not include suitable headings with units. However, for the data that the learner has given the measurements are consistently recorded and so MP2 can be awarded.*

(3

Average Graph

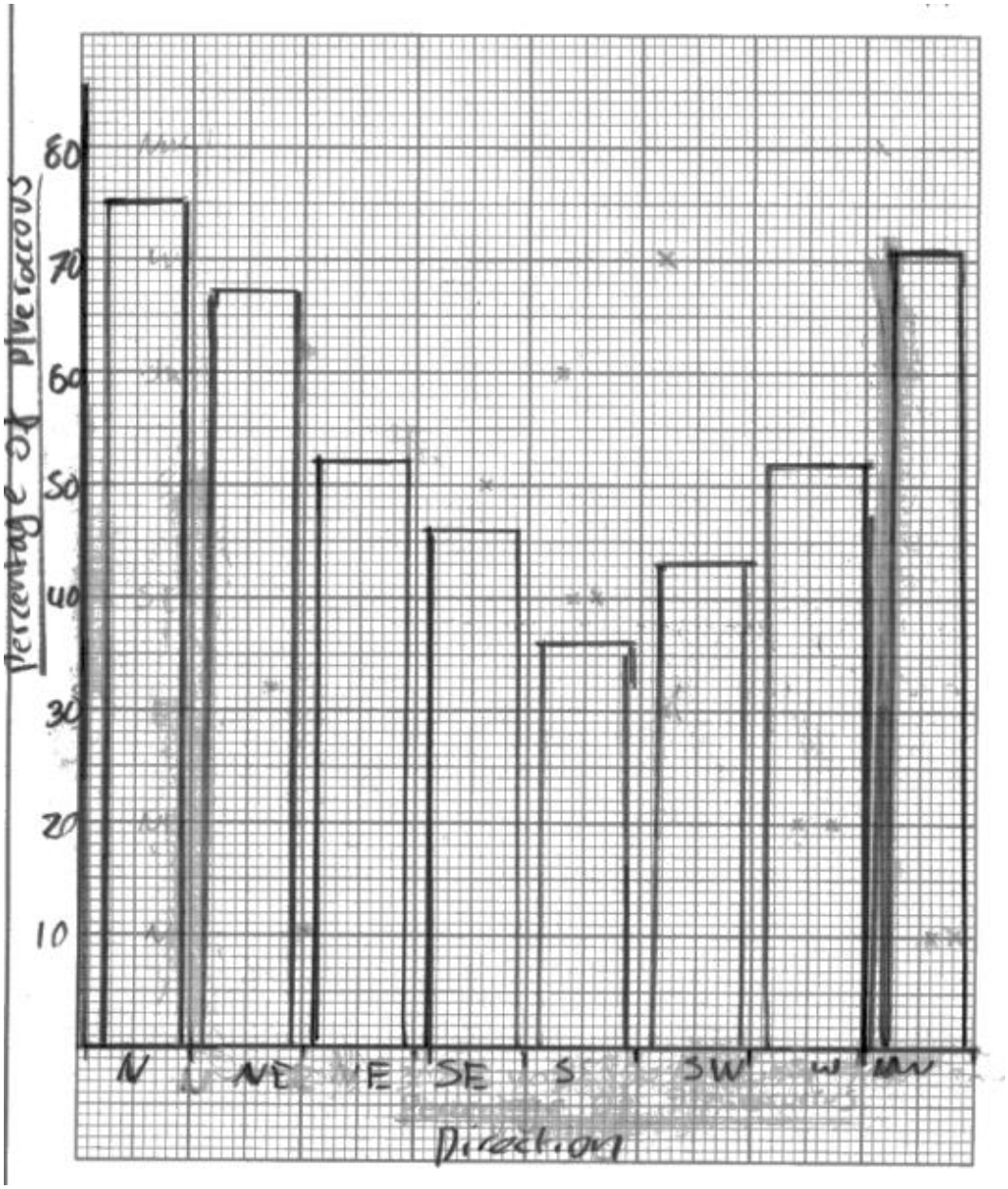
Average Lat obtained for each direction	%	Lux
N	76	
NE	64	
E	52	
SE	44	
S	36	
SW	40	
W	52	
NW	68	

To work out average add all 3 percentages together then devide by 3

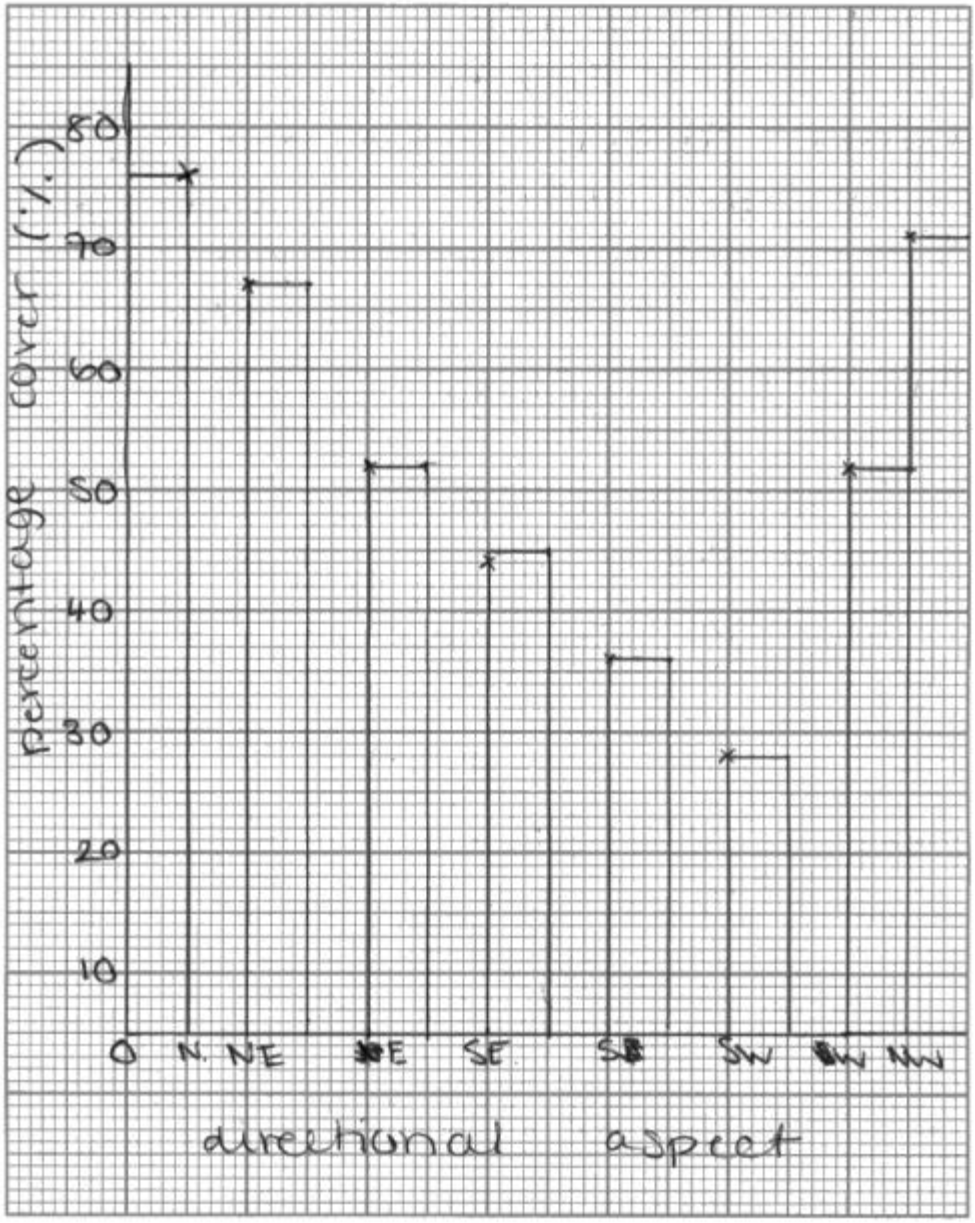
Q1(b)

The majority of learners produced well-plotted bar graphs and most of those who attempted this question obtained at least two marks. There were very few cases of learners confusing axes or producing graphs too small- learners should cover at least half of the graph paper provided in both directions. Marks were most commonly lost for failing to label the axes properly. A significant number of learners misread the question and produced line graphs.

This response was awarded 3 marks. The learner has used the word percentage on the y axis so can be awarded mp1 (although this label could be more accurate). The scale and bars, although unclear, are just acceptable and so MP2 and MP3 can be awarded. The learner has calculated the averages without the anomalous results and have used their mean percentages for the bar heights. Error carried forward from the mean values calculated in Q1(a) can be applied.



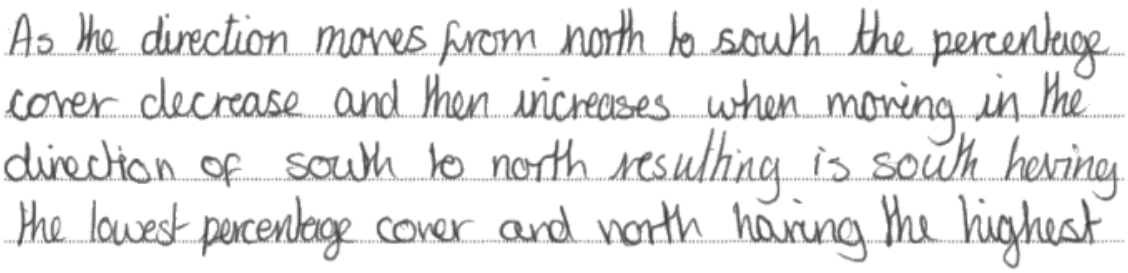
Lead Examiner comment: *This response was awarded 2 marks. We have awarded MP1 for the label and units- direction or directional aspect without a unit for the X-axis, cover % is the minimum acceptable for the Y axis. MP2 for suitable scales has not been awarded because the y axis is not consistent, and the x axis is not consistent- there is no gap between the last two bars. We can accept no gaps or gaps between the bars, but it must be consistent. We have awarded MP3 - all bars drawn correctly according to the incorrect y scale. The height of the bars is consistent with the learner's calculated averages in Q1(a).*


percentage cover (%)
80
70
60
50
40
30
20
10
0
N
NE
E
SE
S
SW
W
NW
directional aspect

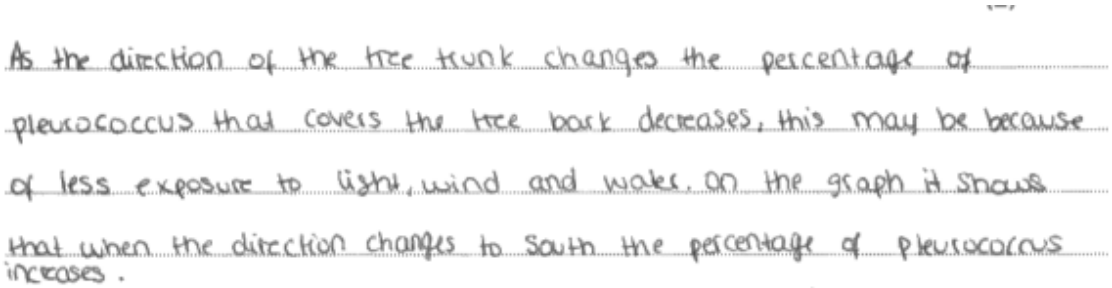
Q1(c)

Most learners achieved one mark for this question, providing either a description of the trend or a statement referring to the minimum/maximum percentage cover. Some learners provided answers were too vague to be credit-worthy while others seemed to believe that the correlation was not strong enough to prove causation. Some learners misread the question and provided an explanation of their results, with reference to light intensity and water evaporation.

Lead Examiner comment: *This response was awarded 2 marks. The learner has described the reduction from north to south so is awarded MP2 (for the trend) The learner has also stated that the minimum percentage cover will be at South/ highest percentage cover will be at North so MP1 can be awarded.*


As the direction moves from north to south the percentage cover decrease and then increases when moving in the direction of south to north resulting is south hevring the lowest percentage cover and north having the highest

Lead Examiner comment: *This response was awarded 0 marks. The learner has not clearly given north or south - just "as the direction changes"- this is too vague to be creditworthy. The last sentence contradicts their data.*


As the direction of the tree trunk changes the percentage of pleurococcus that covers the tree bark decreases, this may be because of less exposure to light, wind and water. On the graph it shows that when the direction changes to South the percentage of pleurococcus increases.

Q1(d)

This question was very well answered, and the majority of students achieved the marking point.

Lead Examiner comment: *This response was awarded 1 mark. This is acceptable learner speak for "local wildlife". A range of possible responses were included in the mark scheme and any reasonable response could be credited.*

(1)

Wild animals

Lead Examiner comment: *This response was awarded 0 marks. Although this could affect the investigation this is not a hazard and so is not creditworthy.*

(1)

dehydration of the tree trunks

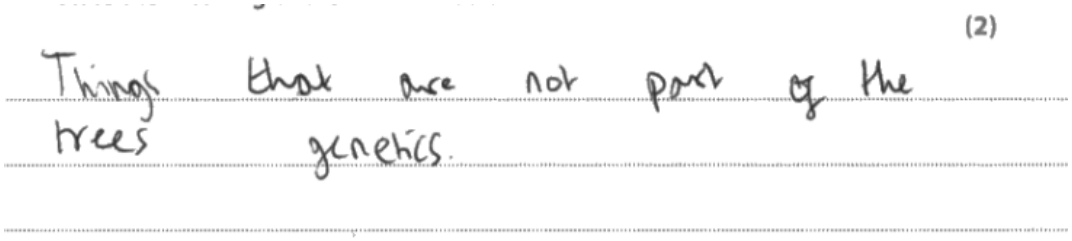
Q1(e)(i)

The majority of learners were able to achieve at least one mark. A large number seemed to not realise that two marks were available and only provided a very short statement, such as “non-living” as a definition. Common errors seen included the phrase ‘non-living organism’ or confusing ‘abiotic’ with ‘antibiotic’ or ‘anaerobic’.

Lead Examiner comment: *This response was awarded 2 marks. The learner has given MP1 and MP2 within their response- non-living factors (MP1) and an example (MP2). The learner can give the response in the context of Pleurococcus rather than generic, and so MP3 is also here but this question has a maximum of 2 marks.*

Non living factors that can affect the percentage of pleurococcus such as wind, water and light intensity

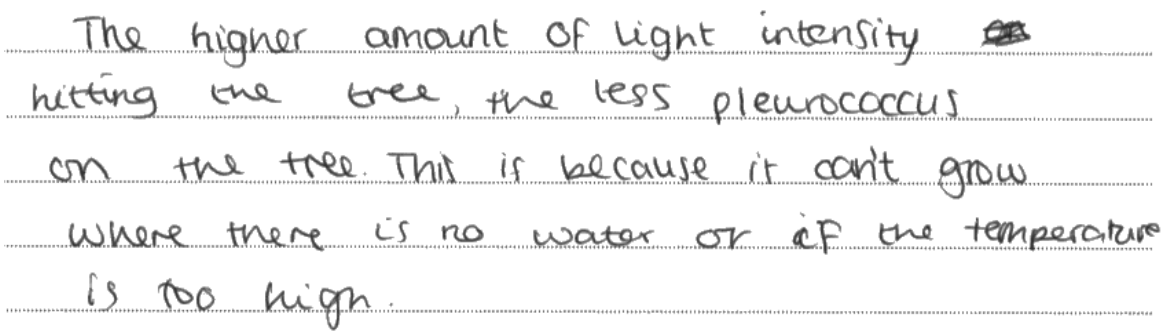
Lead Examiner comment: *This response was awarded 0 marks. The response is too vague - Things that are not part of the tree's genetics could include living features and so is not acceptable as an example (MP2).*



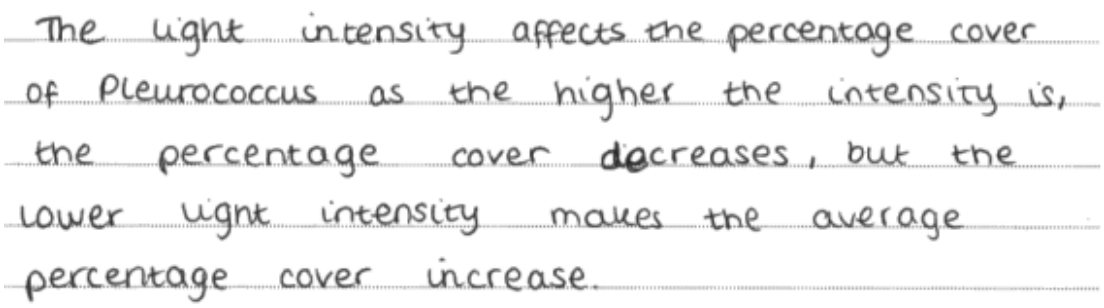
Q1(e)(ii)

On the whole, this question was very well answered. Some learners failed to obtain Marking Point 1 by not specifically linking light intensity to *Pleurococcus* coverage, instead referring to one 'effecting' the other, but were usually able to achieve further marks. A significant minority appeared to ignore the data entirely and make the case that as light intensity increased so did coverage due to increased levels of photosynthesis. Background information has been provided in Part A and the learners are able to refer back to the details given to them in Part A to support their responses to the questions.

Lead Examiner comment: *This was awarded 3 marks. The learner has given the relationship (MP1).*
They have then linked growth (MP2) to the lack of water and the temperature being too high (MP3).
The reference to no water is also just enough for MP4- but the learner has already been awarded the maximum of 3 marks.


The higher amount of light intensity hitting the tree, the less pleurococcus on the tree. This is because it can't grow where there is no water or if the temperature is too high.

Lead Examiner comment: *This response was awarded 1 mark. The response gains MP1 eventually as it refers to a correct relationship. Had it only said light affects percentage cover that would have been too vague for MP1- it should be clear that the higher the light intensity the higher the percentage cover.*

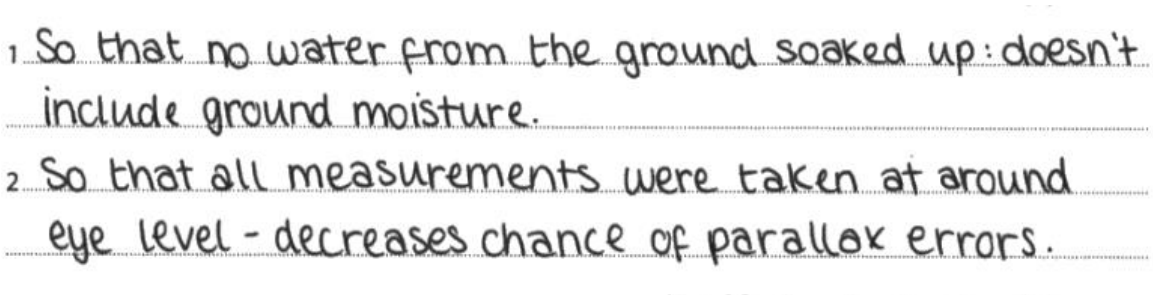

The light intensity affects the percentage cover of Pleurococcus as the higher the intensity is, the percentage cover decreases, but the lower light intensity makes the average percentage cover increase.

Q1(f)

This question was answered well by most of the learners and the idea of being above the height of wildlife interference was well understood and the most common marking point seen. Less common was the idea of there being more moisture closer to the base of the tree which could possibly interfere with the experiment. There was a common misconception seen in some learner answers that the algae would not grow close to the ground because it lacked roots. As light intensity was measured during the investigation this was not a valid reason for selecting the height of 1.5m. Lots of responses made reference to light intensity and how any higher or lower wouldn't get the correct amount of light on the tree or that the height was to avoid shadows.

Lead Examiner comment: *This response was awarded 2 marks. The learner has referenced ground moisture- due to the introduction to the practical provided to the learners this is a common idea. This is creditworthy for MP4- it is sufficient wording for the idea that humidity varies with height above the ground.*

The learner has also given MP2- closer to eye level.


1 So that no water from the ground soaked up: doesn't include ground moisture.

2 So that all measurements were taken at around eye level - decreases chance of parallax errors.

Lead Examiner comment: *This response was awarded 1 mark. We must allow for learner speak- " fair test" is not ideal phrasing, but we can accept this for MP3- for the idea of keeping variables controlled. The learner's comment about the ground affecting the Pleurococcus is too vague to be creditworthy.*

1 so it was always a fair test.

2 so the ground doesnit have effects on the pleurococcus.

Q2(a)

The majority of learners achieved at least 1 mark. Some common mistakes included incorrect decimal placement, rounding errors and power of ten errors.

Lead Examiner comment: *This response was awarded 2 marks. The learner has given two correct forms of the correct answer- we can accept 0.000657 and 6.57 x10-4*
This number would round to 0.0007 can be accepted for 2 marks.
We do not have to investigate the learners working if correct evaluation is given.

$\frac{0.05}{7600.0} \times 100$

$= 6.57\ldots \times 10^{-4}$

percentage error = 0.000657 %

Lead Examiner comment: *This response was awarded 1 mark. The learner has not included the standard form of x 10-4 as part of their response and so has given an answer to the power of 10 to the value we were expecting.*

$$\frac{0.05}{7600.0} = 6.57$$

$$6.57 \times 100 = 657$$

percentage error = 6.57 ~~657~~ %

Q2(b)(i)

This question was less well answered, dividing students by those who knew what a null hypothesis was and those who did not. Even so, the quality of answers appears to have improved slightly over previous years, with more learners referring to significance and chance in their responses.
Among correct answers the idea that there would be no difference between the two tree types was the most commonly seen marking point, with the idea of a significant difference being seen in most responses that scored 2 marks.
Some learners gave their hypothesis, rather than a null hypothesis, and so suggested that one tree would have more growth.

Lead Examiner comment: *This response was awarded 2 marks. The learner has given a succinct null hypothesis.*

There will not be a significant difference in percentage coverage between pine and oak.

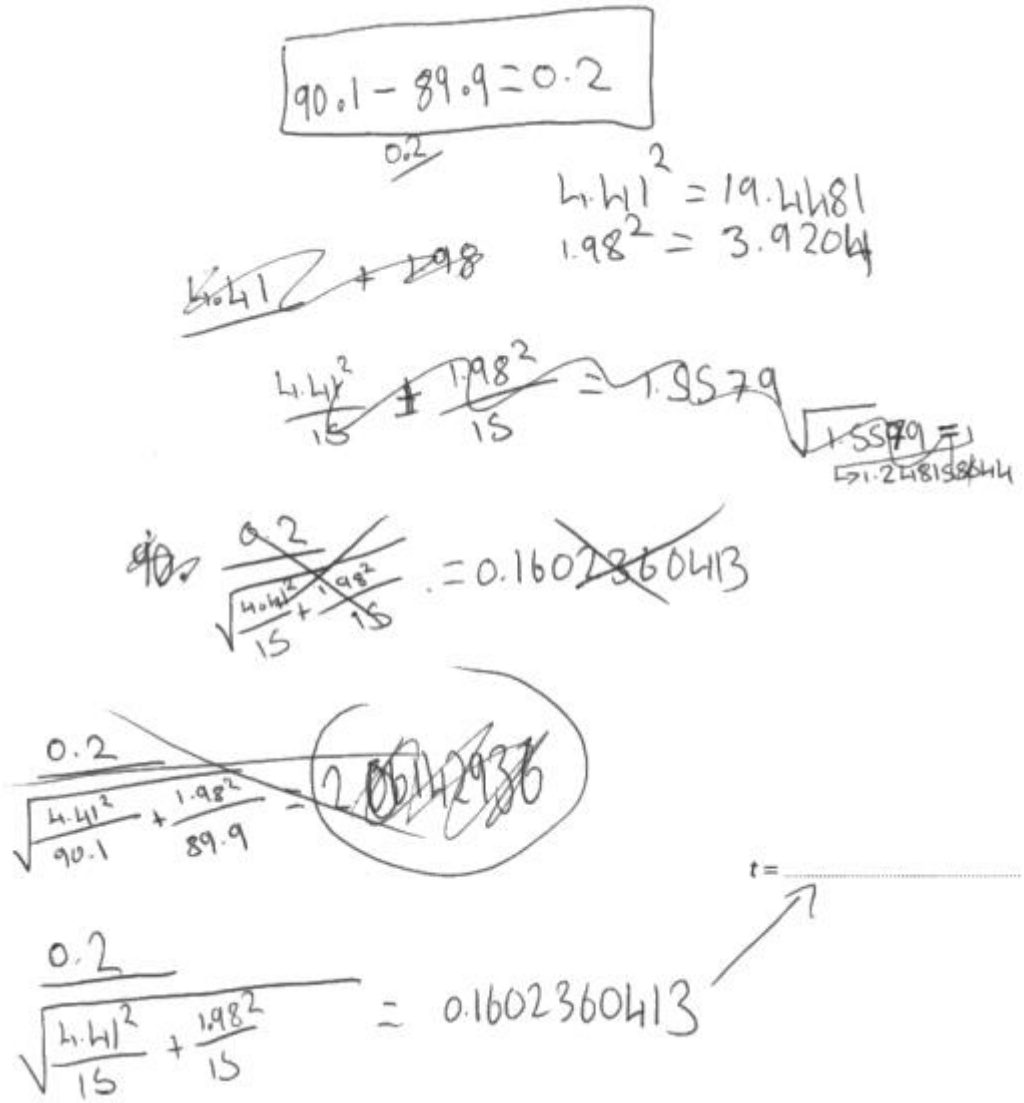
Lead Examiner comment: *This response was awarded 0 marks. Had the learner not suggested 'pine will be higher' then this would have been sufficient for MP3.*
Unfortunately, we cannot award this mark due to this context.

There will be a high percentage cover of Pleurocarpus on both trees, however pine will be higher.

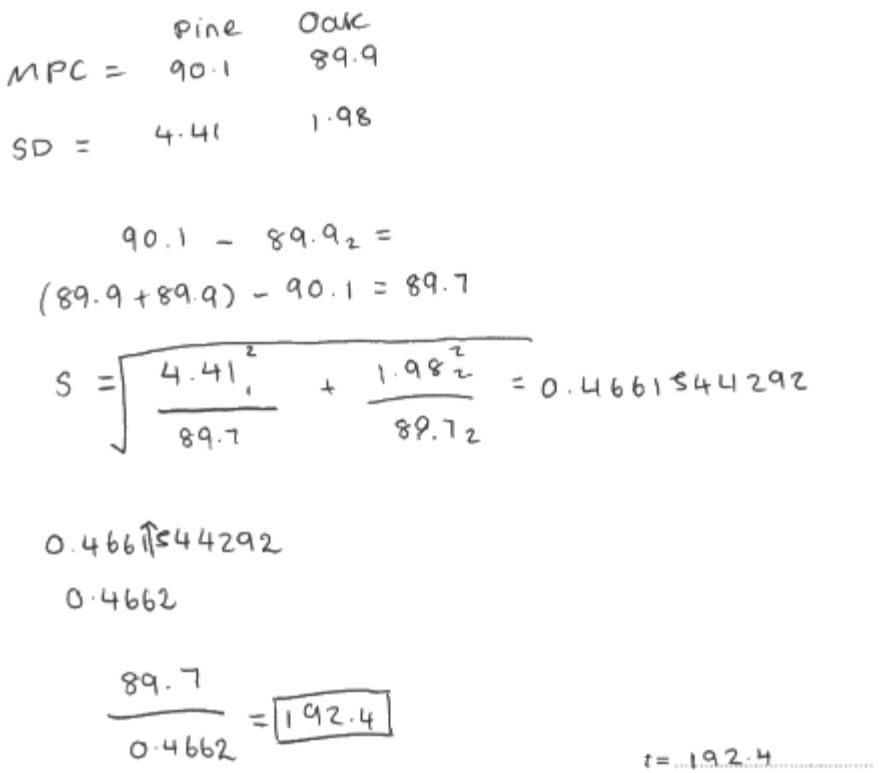
Q2(b)(ii)

The vast majority of learners attempted this calculation. Various parts of this question appeared to have presented the learners with difficulty. The most commonly missed marks were for incorrect substitutions, pot errors, not squaring the SD values, using the incorrect n values and not finding the square root, or failing to carry out the final step.
Some learners were not aware of the mathematical notation of the subscript numbers and so tried to include square or doubling of some of the values.

Lead Examiner comment: *This response was awarded 6 marks. Any number that rounds to 0.16 is correct and therefore receives six marks.*



Lead Examiner comment: *This response was awarded 1 mark. If we do the calculations that the learner has given, we cannot award marks for the difference in the mean or standard error.*
Even the incorrect substitution in the standard error equation cannot be awarded ECF as it has been evaluated incorrectly.
The square root value has not been calculated.
The correct evaluation of the final two incorrect numbers has been awarded 1 mark.

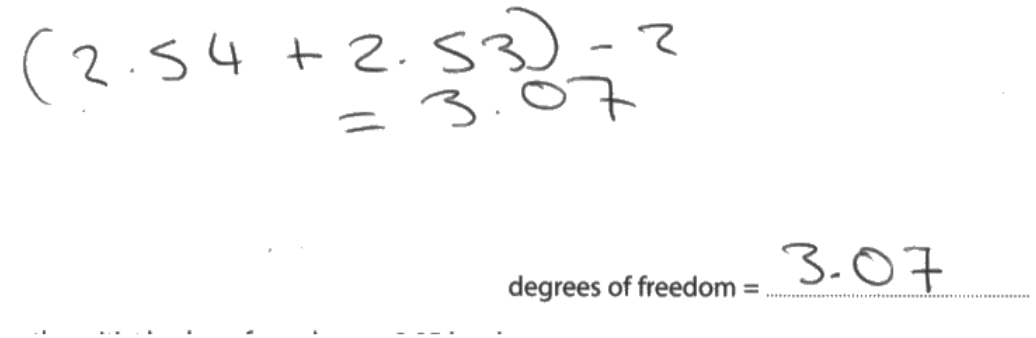


Q2(b)(iii)

The majority of learners achieved full marks. A few learners lost a mark for using incorrect values for n (usually using 14 instead of 15) but gained the ECF mark.

This response was awarded 2 marks. The correct answer- seen often.

Lead Examiner comment: *This response was awarded 0 marks. It is unclear why these values for n have been chosen and so this is an incorrect substitution. As the learner can't just use any numbers and then be awarded ECF, the evaluation mark would not be awarded in this case.*



Q2(b)(iv)

Learners were usually able to use their value from Q2(b)(iii) and Table 2 to give the correct value for the critical value of t.
Learners that had calculated Q2(b)(iii) as 26 were able to be given an error carried forward mark for this question. However, if the learner had not calculated a value between 23 and 30 they tended to guess, add up all the t values or leave this blank. Being unable to select a value from the table should have suggested an error in Q2(b)(iii), but learners did not tend to sense check and amend their previous response.

Lead Examiner comment: *This response was awarded 1 mark. The critical value of t is correct- 2.048*
We can also just accept clear annotation in the t-table for the chosen critical value - as shown here - even without a value written on the answer line.

	p = 0.05
23	2.069
24	2.064
25	2.060
26	2.056
27	2.052
28	2.048
29	2.045
30	2.042

Degrees of freedom

Table 2 – *t* table

critical value of t = 2.048

Lead Examiner comment: *This response was awarded 0 marks. Although the learner has 28 in Q2(b)(iii) as their degrees of freedom, they have not used the t-table correctly and so the critical value of t is incorrect.*

	p = 0.05
23	2.069
24	2.064
25	2.060
26	2.056
27	2.052
28	2.048
29	2.045
30	2.042

Degrees of freedom

587/250 = 2.348

Table 2 – *t* table

4109/250

critical value of t = 2.348

Q2(b)(v)

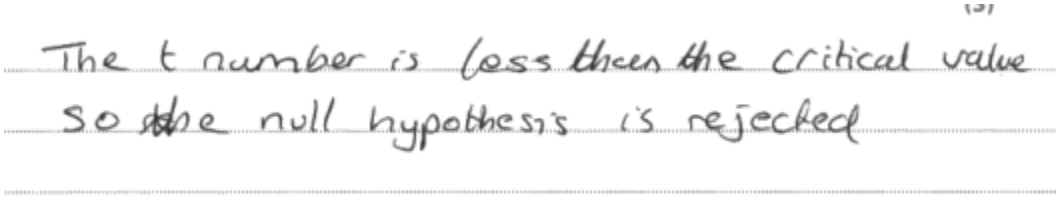
Although improved on previous years, the majority of responses to this question still showed a lot of confusion.
Most learners, even if they hadn't attempted the previous questions, suggested that the null hypothesis could be accepted.
However, some learners changed their mind mid-answer, contradicting themselves or the data or calculated values. Learners often struggled to apply the calculations from the questions above to this question with many who went through the previous three items correctly making a generic statement about the hypothesis in terms of the raw data rather than the statistical tests. Most learners who scored marks beyond MP1 for "accept", achieved them for a comparison of the t test and critical values. Some learners were then able to add a final third point, such as there was no significant difference.

Lead Examiner comment: *This response was awarded 2 marks. The learner has changed their mind about reject or accept the null hypothesis- we mark the response we can see and so this is MP1. The learner has not given sufficient for MP2 with their comment that our critical value is bigger than our results- although we don't have the exact wording from the mark scheme this phrasing does not suggest the t value- "results" could be the raw data. The probability could be due to chance is sufficient for MP3.*

(v) Explain whether the null hypothesis should be accepted or rejected. (3)

accept.
we ~~reject~~ the null hypothesis as our critcal value is bigger than our results. This probability could be due to chance.

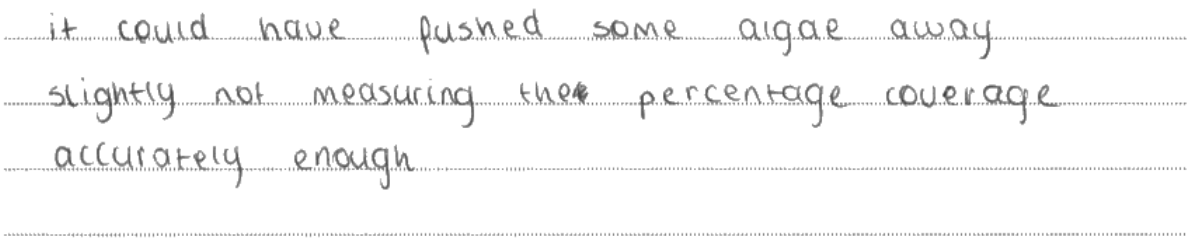
Lead Examiner comment: *This response was awarded 1 mark. The marking points can be considered as standalone, Although the learner is incorrect about rejecting the null hypothesis (this is marking point 1), they have provided a correct statement that the t- number is less than the critical value. t-number is sufficient for t-test value and this statement is consistent with the learner's previous calculations throughout question 2. Therefore 1 mark can be awarded for MP2.*



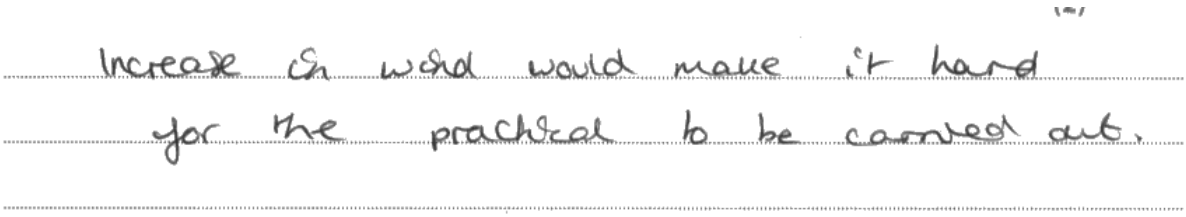
Q3(a)(i)

Many learners referred to wind blowing algae off the trees or drying it out, but few were able to link this to a reduction in cover, tending to use vague terms such as 'effect'. The majority of learners were able to refer to the idea of false or misleading readings.

Lead Examiner comment: *This response was awarded 2 marks. The response gives mp1 (pushed algae away) and MP3 (false reading).*
It must be clear that the algae has been removed from the tree and a reference just to damage of the algae is insufficient.



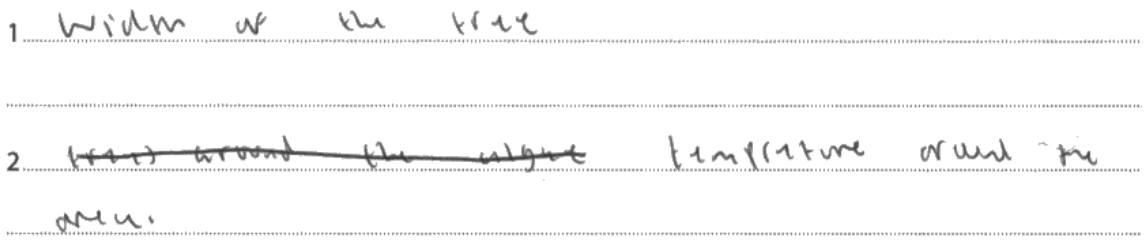
Lead Examiner comment: *This response was awarded 0 marks. Although this could be a true statement this is not answering the question.*



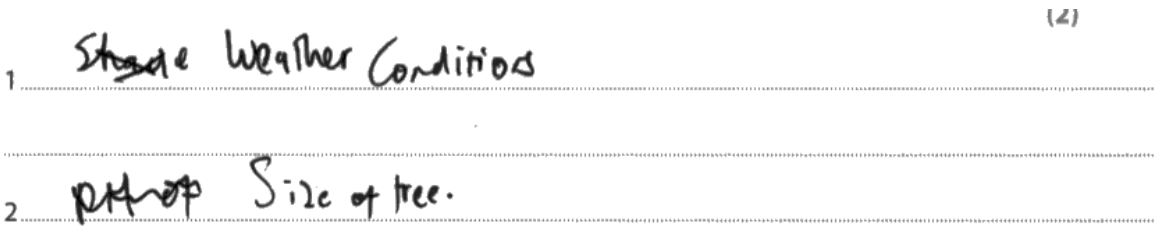
Q3(a)(ii)

This question was generally well answered, but many learners lost marks by not qualifying their references to weather or only mentioning 'wind' or 'light'. Many did not realise that the 'two other' part of the question referred to the whole experiment and not just Q3(a)(i).

Lead Examiner comment: *This response was awarded 2 marks. Width of tree is equivalent to age/circumference of tree. Ambient temperature is credit worthy.*



Lead Examiner comment: *This response was awarded 0 marks. 'Weather' is not credit worthy. Size of tree is too vague as it could relate to the height, and we can control that by choosing a different tree.*



Q3(b)

Many students appear to have been confused by this question, assuming that improving the validity of the data would require expanding the scope of the experiment or re-writing the method. Where repeats were mentioned, it was most commonly in the context of repeating the investigation with different types of trees or at different times of year. Among the few merit-worthy responses seen, the idea of repeating the experiment more times to obtain a more accurate mean was mentioned by the higher-scoring learners.

Very few learners considered using a quadrat with smaller increments as a way of improving the values and fewer suggested using a machine or weighing the *Pleurococcus* would be more accurate than counting the quadrat squares for the percentage cover.

Lead Examiner comment: *This response was awarded 2 marks. Repeating each reading is enough for MP1. The reference to more accurate mean is equivalent to MP2 but must include the word mean/average and not just more accurate results.*

(4)

1 repeat each reading twice more to gain a more accurate mean average, and to also decrease the chance of anomalies skewing the data.

2 complete this experiment at other areas of the forest such as those in a windier/colder environment, to see if temperature affects the growing rate.

Lead Examiner comment: *This response was awarded 0 marks. Both ideas here are for different investigations so neither is equivalent to MP1.*

1 They could ~~chose~~ investigate at diggerent heights eg the tree, for example 2.5m. I could at percentage cover at diggerent parts of the tree, ~~those~~ closer to the ground, higher up the bark.

2 They could do it at diggerent times of the year, winter months or autumn.

Summary

To improve in future series, learners should continue to practice exam technique, ensuring that they know what is required by specific command words and know the difference in what is required from commands such as explain how and explain why. Learners should ensure that they are specific with their answers rather than giving vague or general answers.

They should practice drawing tables and graphs, ensuring that they label axes, including units and that they use linear scales that are appropriate so that their data spread takes up at least half of the paper that they are using. Learners should ensure that they are drawing the required type of graph.

Learners should ensure that they understand basic mathematic principles such as mathematical notation, such as “n”, writing answers in standard form and rounding of answers.

Learners should consider the variables within the given method and improvements that could be made during the preparation time, so that they can visualise the investigation before being presented with the questions.

The Specification and/or Sample Assessment Materials (SAMs) is located on the BTEC Nationals qualification webpage here.

Individual Questions

Chemistry

Q4

This question tests the ability of the learner to plan a scientific investigation. This includes the development of a hypothesis, the selection and justification of equipment, techniques and standard procedures, health and safety and methods of data collection including, quantities to be measured, number and range of measurements to be taken, how the equipment is to be used, control variables and a brief method for data collection analysis.

Q4 is a levels-based question using four levels of attainment. For each level there is a range of three marks and once the level is decided looking at the work as a whole, the quality of work presented within that level is assessed. The four levels of attainment are described by the generic mark scheme with a mark out of 12.

The investigation that learners had to plan an investigation into how the number of carbons in an alcohol molecule affects the amount of heat energy produced per gram of alcohol. The majority of learners were able to give a hypothesis based around the energy produced by alcohols molecules containing a different number of carbon atoms. However, few linked their hypothesis to the amount of energy released per gram of alcohol and fewer still were able to justify their hypothesis.

The majority of learners were able to give a list of relevant equipment with some being able to justify why each piece was required. Learners often gave safety considerations. Weaker learners gave generic safety precautions such as tying hair up, pushing chairs under tables or wearing goggles. More proficient learners gave hazards and risks specific to the experiment. When planning their experiment some learners did not consider measuring the mass of the alcohol or measuring the temperature of the water before and after burning the alcohol, therefore meaning that valid results would not have been obtained. The weakest learners planned to burn the alcohols but did not make it clear that the burning alcohol would be used to heat a volume of water, showing that they were unsure about the principles of calorimetry. Learners who planned the practical correctly often neglected to fully explain how the data would be handled. Very few learners included equations for calculating energy per gram. Often when the calculation was included, they did not make it clear that the mass of water is multiplied with

c and ΔT and that this expression was then divided by the mass of the fuel burnt.

The following are examples of responses seen.

Lead Examiner comment: *In the first example, the learner has given a confused hypothesis, they have given a basic method, it is in a logical order but there is a big omission as there is no reference to measuring temperature. Some equipment has been given with weak explanations and the health and safety covered is mostly generic. Therefore, a mark of 2 in Level 1 was awarded.*

SECTION 2

4 The alcohols are a group of organic compounds. Alcohols can be used as fuels.

Table 3 shows five alcohols and the number of carbon atoms per molecule.

alcohol	number of carbon atoms per molecule
methanol	1
ethanol	2
propan-1-ol	3
butan-1-ol	4
pentan-1-ol	5

Table 3

When alcohols are burned they release heat energy.

You have been asked to write a plan for an investigation into how the number of carbon atoms in an alcohol molecule affects the amount of heat energy produced per gram of alcohol.

Your plan should include the following details:

- a hypothesis
- selection, and justification, of equipment, techniques or standard procedures
- health and safety associated with the investigation
- a step-by-step method for data collection and analysis to test the hypothesis including:
  - quantities to be measured
  - number and range of measurements to be taken
  - how equipment may be used
  - control variables
  - brief method for data collection analysis.

(12)

Hypothesis = as the ~~no~~ alcohol reactivity increases, the carbon molecules also increase due to more heat energy being produced.

Equipment -

* ~~Beaker for the alcohol to be placed in and~~

Measured in.

~~• Measuring cylinder - to measure the alcohol out~~

~~• Pipette - to make the measuring out more accurate~~

~~• Bunsen burner to heat the alcohol.~~

• Balance - to weigh out the mass before + after.

• Heat proof mat - to protect the table from spillages.

~~• Heat proof for the alcohol to sit on + heat~~

• Alcohol ~~flame~~ canister + wick

Health + safety -

• Hair tied back - get away from the naked flame.

• Goggles - for protection as alcohol can be irritant.

• Wear - could burn skin if touched with naked flame

Method:

1. Collect your equipment and ~~place~~ set up.
~~the bunsen with your mat tripod and gauze.~~
2. Place the alcohol on the balance and read and place the reading in a table of the mass before heating.
3. Once measured begin heating by placing the wicks on top to light.
4. Once it's finished burning, place back on the balance and read the mass.
5. Repeat steps 2 - 4 until all the alcohols have been completed and ~~rep~~ repeated 3

times over.
6. once over, calculate your heat energy by using the equation: $m \times C \times \Delta T$ with your averages.

Variables:
Inaependent - Alconol used.
Dependent - the number of carbon atoms
Control - heat. [redacted], equipment used.

For data analysis it should be placed in a table similar to this:

Alcohol	Heating mass (g) before			after			mean
	1	2	3	1	2	3	
Methanol							
Ethanol							
pentanol							
Propane							
Butanol							

Lead Examiner comment: *In this example, A hypothesis has been given, but it does not refer to the heat produced per gram of fuel. A basic method has been given, it is in a logical order and makes reference to mass being measured, there is no reference as to how the data will be dealt with. All equipment has been listed but with no justification as to why it is needed some basic health and safety is relevant has been given but is weak Therefore a mark of 5 in Level 2 was awarded.*

SECTION 2

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  - how equipment may be used
  - control variables
  - brief method for data collection analysis.

(12)

Hypothesis:

I predict that the higher the carbon atoms per molecule in the alcohol, the greater the heat energy released. This is because the more molecules there are, the more collisions there will be meaning more energy

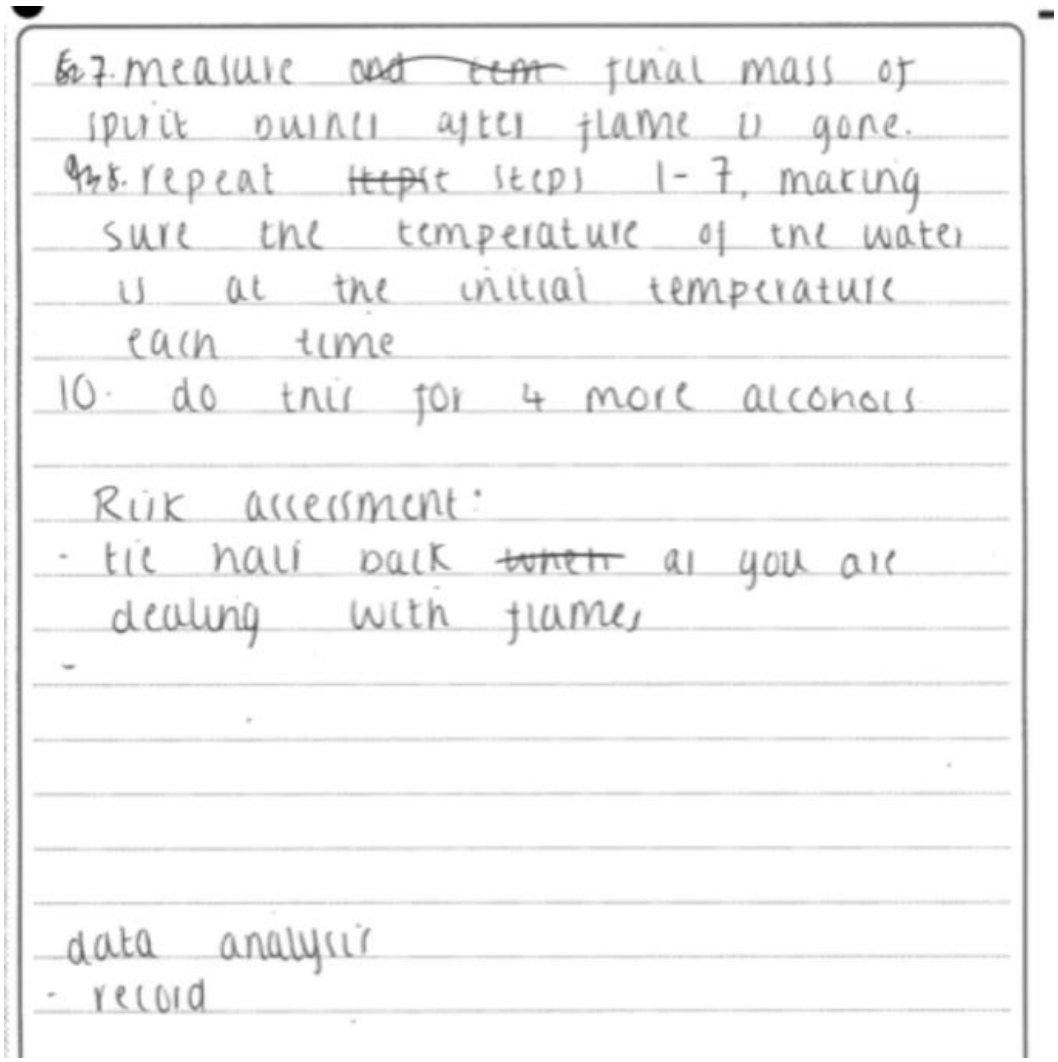
will be released.

Equipment:

- ~~burner burner~~
- thermometer
- clamp
- spirit burners (5)
- ~~tripod~~
- weighing scale
- water
- lid
- beaker
- heat proof mat

Method:

1. ~~measure the spirit burner and record the mass~~
2. ~~set up burner burner and place on safety flame~~
3. measure the weight of spirit burner and record mass
4. place 50 cm^3 of water into a beaker and attatch to the clamp
5. measure initial temperature of water and record
6. set spirit burner alight and hold it 25cm under the beaker
7. place lid and thermometer into beaker so ~~not near~~ heat loss is reduced.
8. Wait until max temperature is reached and record it


7. measure ~~out tem~~ final mass of spirit burner after flame is gone.
8. repeat ~~steps~~ steps 1-7, making sure the temperature of the water is at the initial temperature each time
10. do this for 4 more alcohols

Risk assessment:
- tie hair back ~~when~~ as you are dealing with flame,
-

data analysis
- record

Lead Examiner comment: *In this example, the learner has given a hypothesis but they have not referred to heat energy per gram. They have given a logical method that would yield reliable results. They have given control variables and a table for results. A full list of equipment has been given with an explanation for each piece. One relevant hazard has been explained. A mark of 10 in Level 4 was awarded.*

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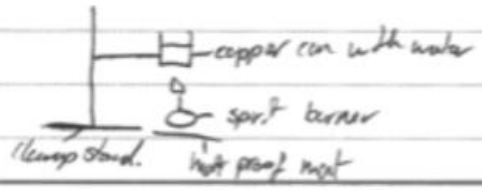
  - quantities to be measured
  - number and range of measurements to be taken
  - how equipment may be used
  - control variables
  - brief method for data collection analysis.

(12)

As alcohols are burnt they release heat energy this is because the carbon molecules in the fuels are being combusted into carbon dioxide or carbon monoxide depending if the energy combustion is complete. This allows me to assume that pentan-1-ol will release the most heat energy because more carbon atoms are being burned, however this method is created the most safe.

equipment & justifications:

- a spirit burner containing ~~of~~ the fuel with a cap
  this is because it allows for ~~easy~~ and safe combustion of ~~the~~ fuel.
- a calorimeter ~~is~~ copper can
  this allows the ~~heating~~ water to be measured
- digital thermometer ~~which~~ which reads to 0.01°C
  this allows the data recorded to be more accurate and therefore ~~d~~ reliable
- 250ml measuring cylinder
  this is to allow 200 ml of water to be measured and poured into the copper can
- clamp stand & clamp
  this is to allow the copper can to be held at a height which allows complete combustion to take place.
- ~~the~~ heat resistant mat
  ~~e~~ the spirit burner will sit on this, this prevents the table from getting damaged
- lighter & splint
  this allows the ~~spi~~ splint to be ~~light~~ lit on fire allowing the spirt burner to be lit
- weighing scale that measures ~~only~~ 0.01g
  this allows more accurate mass changes to be recorded.
- cardboard lid for the copper can
  ~~inexpensive~~
  insulator



measurements which need to be taken & standard procedures

the start ⍙ and temp of the water in the copper can. To do this remove the card board lid and stir the water with the thermometer for 30s and then take the reading

- measure the start ⍙ and mass of the spirit burner with the lid on. To do this turn on the scales and tare them. Then add the spirit burner and record the masses

in the table bellow.

alcohol	start temp 1 2 3	end temp 1 2 3	⍙ temp 1 2 3 change	start mass 1 2 3	end mass 1 2 3	change 1 2 3

method

1. weigh spirit burner + record start mass value
2. measure out 200ml of cold water in the measuring cylinder and pour into the copper can.
3. take start temperature of the water.
4. light the spirit burner
5. allow the temp to rise 30°C
6. put lid on the spirit burner an weigh it.
7. record the mass value.
8. repeat for each alcohol 3 times

Health & Safety.

this experiment should take place in a well ventilated room, this allow the movement of carbon dioxide and the carbon monoxide gasses this prevents fainting and lack of oxygen related asphyxiation.

Students should also be allowing a 1cm gap between the top of the flame

and the copper can be reduce ~~carbon~~ carbon monoxide production.

The control variables of this experiment are:

- using the same copper can
- using the same digital thermometer
- using the same cardboard lid for the can
- using the same weighing scales
- using the same measuring cylinder
- ~~using the same~~

(Total for Question 4 = 12 marks)

Q5

This question gives a description of the method, results and conclusion of an investigation and tests the ability of learners to use this information to make recommendations to improve the method, determine possible sources of error, consider the reliability or otherwise of data and evaluate the conclusions given with respect to the results given for the investigation.

When considering the method used, whilst learners could see errors and omissions in the method, few were able to explain why it was important to specify quantities such as the volume of water used, the mass of the snack and the length of time for which the snack was burnt. Very few learners made the link that these variables could affect the amount of energy transferred to the water. Many learners were able to identify that the learner did not repeat their experiment and that this made it impossible to identify anomalies in data so the data presented could not be considered to be reliable. The majority of learners were able to conclude that the conclusion was not correct, that looking at final temperature was not appropriate, and that the change in temperature should have been considered instead.

Most were able to spot that bacon fry had the highest temp change with many calculating the correct value and using these to come their own correct conclusion. Very few learners recognized that just looking at change in temperature as a measure of energy was not valid and that energy per gram would need to be determined to make the comparison of snack foods more valid.

The following are examples of responses seen.

Lead Examiner comment: *In this first example, the learner has written very little. It may be that they had run out of time. The learner has written their answer in terms of some 'questions' about the method. Although they are questions, they do show some basic understanding about the weaknesses in the method and a mark of 2 in Level 1 was awarded.*

5 A learner wanted to find out which of four snack foods contained the most energy.

The learner investigated the energy content of different types of snack food.

Here is the learner's method.

- Fill a test tube half way with water.
- Measure the initial temperature of the water.
- Place one snack on a mounted needle.
- Set the snack alight and place it under the test tube containing the water.
- Measure the final temperature of the water.

Table 4 shows the results of the learner's investigation.

type of snack food	starting temperature of the water (°C)	final temperature of the water (°C)
onion ring	24	56
cheese ball	26	51
bacon fry	22	55
prawn cocktail shell	25	45

Table 4

The learner concludes that:

'The snack with the highest energy content is the onion ring because the final temperature of the water is the highest. Next is the bacon fry then the cheese ball, and the prawn cocktail shell has the lowest energy content.'

Evaluate the learner's investigation.

Your answer should make reference to the:

- method of the experiment and equipment used
- results collected
- conclusion made.

(8)

Method

- How much water
- Measure the inital temperature with what
- how far under the test tube
- Measure the final temperature with what

Lead Examiner comment: *In this example, the learner has given two issues with the method. They show an understanding that the lack of repeats means that no mean can be calculated. They have used the table to calculate the correct change for each snack and given the correct conclusion. A mark of 5 at the top of Level 2 was awarded.*

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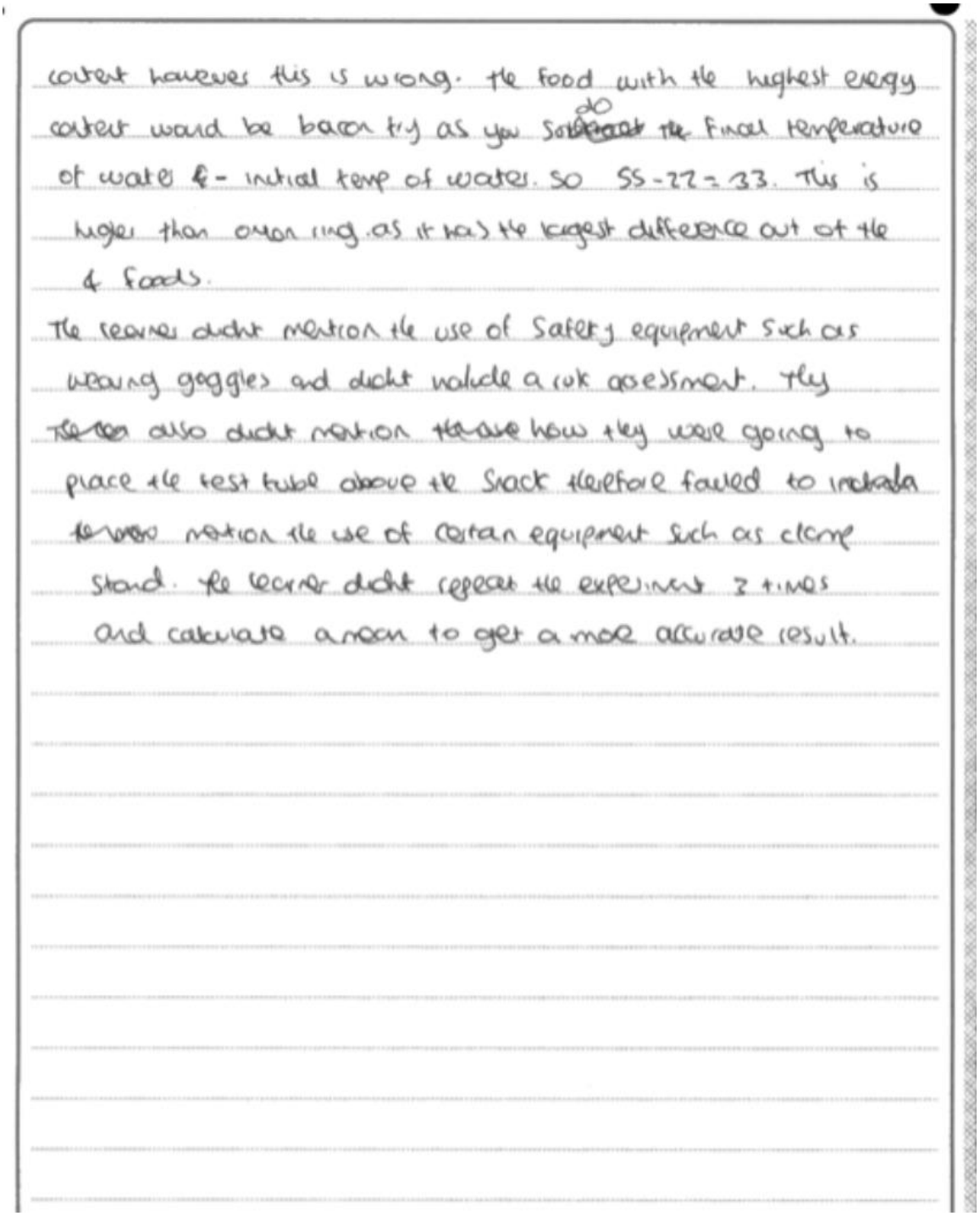
Evaluate the learner's investigation.

Your answer should make reference to the:

- method of the experiment and equipment used
- results collected
- conclusion made.

(8)

- the learner didn't mention the ~~amount~~ specific amount of water they used as they didn't include any measurements
- when they placed the snack underneath the test tube, they didn't state the distance and time that it should be kept at from the test tube.
- the learner states that the onion ring has the highest energy



content however this is wrong. the food with the highest energy content would be bacon fry as you do the final temperature of water - initial temp of water. so 55-22=33. This is higher than onion ring as it has the largest difference out of the 4 foods.

The learner didn't mention the use of safety equipment such as wearing goggles and didn't include a risk assessment. They also didn't mention how they were going to place the test tube above the stack therefore failed to include to mention the use of certain equipment such as clamp stand. The learner didn't repeat the experiment 3 times and calculate a mean to get a more accurate result.

Lead Examiner comment: *In this final example, the learner has stated that in the method the volume of water should be measured and develops this by saying maybe 10ml should be used. They have explained that in the method the mass of the food should be measured and explained why. They have explained that in the results, the results should be repeated, so that anomalies can be found*
They have explained that the conclusion is wrong as it should have been based on the change in temperature and then discussed what the results should have been, having calculated the correct temperature changes at the top of the page by the table. The learner has developed ideas in all three areas, method, results and conclusion and so a mark of 8 in Level 3 was awarded.

5 A learner wanted to find out which of four snack foods contained the most energy.

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Here is the learner's method.

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- Measure the initial temperature of the water.
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The learner concludes that:

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Evaluate the learner's investigation.

bacon, onion, cheese, prawn.

Your answer should make reference to the:

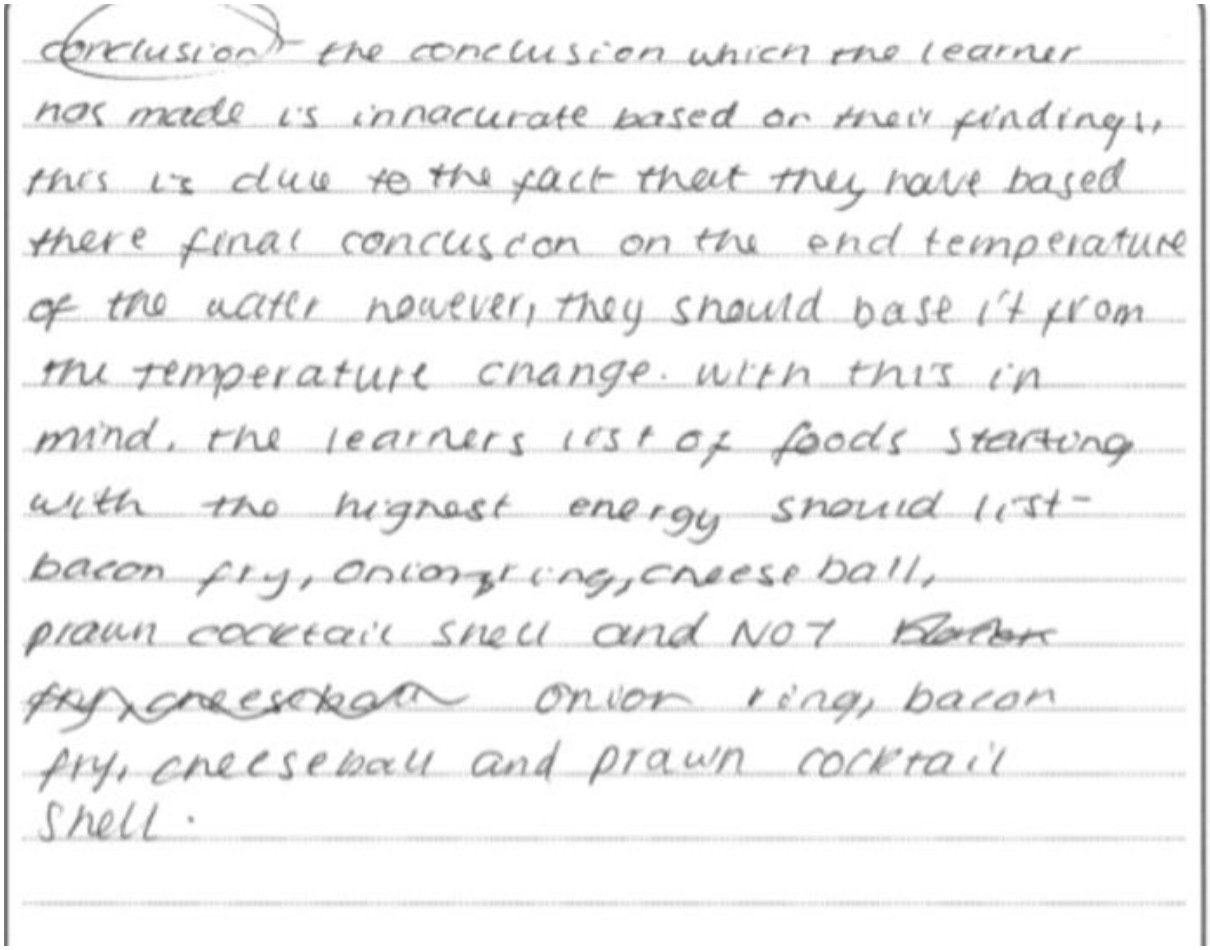
- method of the experiment and equipment used
- results collected
- conclusion made.

(8)

method - the learners method will not provide valid and accurate results if it was to be reproduced. They have not listed specific values of measurements - 'fill the test tube half way' should say, fill the test tube with 10ml of water and measure

and record the initial temperature · Another the reason this experiment will not be accurate is due to the fact that the learner has not weighed and recorded the mass of each piece of food which has been used, this needs to be done as wright will have an effect on the amount of heat energy released · Another issue with the learners method is that they have not ~~listed the e~~ mentioned the equiptment used within each step, meaning it will be difficult to reproduce ·

Results The learners results have been shown in a table however, it is hard to understand if a fair investigation has been conducted, this is because the learner should have timed how long each snack food was alight and recorded this in their table · Another way the results can be enhanced is by the learner carrying out ~~each~~ the experiment 3 or more times for each different food, this should be done so that it is easy to identify anomalys results · Another way the results can be improved is by the learner including a section labelled 'change in temperature' this is so results can easily be compared and analysed .


Conclusion - the conclusion which the learner has made is innacurate based on their findings, this is due to the fact that they have based there final conclusion on the end temperature of the water however, they should base it from the temperature change. with this in mind, the learners list of foods starting with the highest energy should list- bacon fry, onion ring, cheese ball, prawn cocktail shell and NOT ~~fry cheeseball~~ onion ring, bacon fry, cheeseball and prawn cocktail shell.

Summary

To improve learners should plan their time across the whole paper so that they are able to finish all of the questions set in full, they should ensure that they answer all parts of the question and to give developed answers rather than giving generic or basic ideas only. Learners should be taught about the difference between accuracy and reliability.

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